



Molar Mass Determination From Freezing Point Depression

Topical Unit of Instruction: Solutions-Colligative Properties

Introduction

This lab uses mostly non-toxic lauric acid combined with a small amount of benzoic acid which is only slightly toxic. The chemicals can be reused from year to year.

Time

50 minutes for data collection

50 minutes for processing data

Objective

1. To calculate molar mass of a solute from freezing point depression.
2. To generate a cooling curve for a typical solution.

Preparation

1. Carefully pre-measure 2.00 g benzoic acid and 16.00 g of lauric acid for each test tube. Parafilm[®] until ready to use. It is wise to set up an extra test tube just in case students accidentally stir through a test tube with the thermometer. Check thermometer labels. It is imperative that each lab pair use the same thermometer for the benzoic/lauric acid mixture in this lab that they used in the pure lauric acid for "Heating and Cooling Curves."

Safety Reminders

1. Students need to stir the melted solution with the thermometer very carefully, or they will stir the bottoms out of the test tubes.
2. Students need to be reminded not to touch anything hot with their skin.

Materials

(For a class of 32 students working in pairs)

- 16 large test tubes (25 x 150 mm work well) containing 2.00 g benzoic acid plus 16.00 g lauric acid
- 16 test tube holders
- 32 large (400-600 mL) beakers
- 16 hot plates (8 will do if two pairs share!)
- 32 thermometers (16 labeled from "Heating and Cooling Curves" lab)
- clock (or watches) with second hand
- 32 sheets of graph paper



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Typical Results:

1. $\Delta T_f = 4.0^\circ\text{C}$
2. $\Delta T_f / K_f = m = 1.03 \text{ moles/kg}$
3. $g / (1,000 \text{ g/kg}) = 0.01600 \text{ kg lauric acid}$
4. $m \cdot \text{kg} = (1.03 \text{ moles/kg}) (0.01600 \text{ kg}) = 0.0165 \text{ moles benzoic acid}$
5. $(\text{g/moles}) = (2.00\text{g} / 0.0165 \text{ moles}) = 121 \text{ g/mole}$
6. C: $7 \times 12.0 = 84.0$
H: $6 \times 1.0 = 6.0$
O: $2 \times 16.0 = 32.0$
122 g/moles
7. $122 - 121 / 122 \cdot 100 = 1\%$

Disposal

Test tubes can be Parafilmed[®] and reused indefinitely.

Hint

This lab could be easily adapted to computer or graphing calculator temperature probes. However, as with thermometers, each pair of students must use the same probe that they used in the pure lauric acid in the "Heating and Cooling Curves" lab.

